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Shrub-Steppe Habitat Types of Middle Park, Colorado

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Abstract

Shrub-steppe vegetation was classified into 17 habitat types in relation to plant species canopy cover, and physical characteristics. Grazing and browsing by wildlife and livestock are expected to continue to influence the development and maintenance of stable plant communities in Middle Park. The habitat types emphasize critical mule deer winter range and are considered climax, each modified by zootic, edaphic, climatic, and/or landform factors. Phyto-edaphic characteristics, ground photos, and a habitat type key are presented and discussed. This classification and associated descriptions of habitat types provide the basic ecological information necessary to aid in land management planning and monitoring of the shrub-steppe plant communities in Middle Park and similar environs.

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Shrub-Steppe Habitat Types of Middle Park, Colorado[1]

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Contents

	Page
MANAGEMENT IMPLICATIONS	1
INTRODUCTION	1
LITERATURE REVIEW	1
STUDY AREA	1
METHODS	2
RESULTS AND DISCUSSION	3
Climax Categories	3
Soils	4
Statistical Summaries	4
HABITAT TYPES WITHIN THE CRITICAL WINTER RANGE	4
Artemisia tridentata tridentata/Agropyron smithii h.t.	4
Sarcobatus vermiculatus-Artemisia tridentata tridentata/ Agropyron smithii h.t.	5
Artemisia tridentata wyomingensis/Agropyron smithii h.t.	10
Artemisia tridentata wyomingensis/Agropyron spicatum h.t.	11
Agropyron spicatum/Artemisia frigida h.t.	11
Juniperus scopulorum/Agropyron spicatum h.t.	12
Artemisia tridentata vaseyana/Festuca idahoensis h.t.	12
Amelanchier alnifolia/Agropyron spicatum h.t.	13
Amelanchier alnifolia/Carex h.t.	13
Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule h.t.	14
Oryzopsis hymenoides-Eriogonum brevicaule h.t.	14
HABITAT TYPES OUTSIDE THE CRITICAL WINTER RANGE	15
Artemisia longiloba/Poa secunda h.t.	15
Artemisia tridentata wyomingensis/Stipa columbiana h.t.	15
Purshia tridentata-Artemisia tridentata vaseyana/Festuca idahoensis h.t.	16
Agropyron spicatum/Poa fendleriana h.t.	16
Artemisia tridentata vaseyana/Festuca thurberi h.t.	16
Artemisia cana/Festuca thurberi h.t.	17
LITERATURE CITED	18
APPENDIX. Key to the Shrub-Steppe Habitat Types of Middle Park, Colorado	19

Shrub-Steppe Habitat Types of Middle Park, Colorado

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MANAGEMENT IMPLICATIONS

This classification and the associated descriptions of habitat types provide the basic ecological information necessary to aid in land management planning and monitoring of the shrub-steppe plant communities of the critical mule deer winter range in Middle Park and similar enviorns.

INTRODUCTION

The purpose of this study was to quantify, classify, and describe the shrub-steppe vegetation of Middle Park, Colorado, including critical mule deer winter range. Critical winter range refers to those lower-elevation areas that mule deer depend upon for survival during winters of deep snow. Habitat type classification is based upon the study of relatively stable, climax plant associations (Daubenmire 1970). The habitat types were identified based upon their position in the landscape, edaphic characteristics, and their current stable climax plant communities, without reliance on relic stands in "climax pristine conditions."

Technical terms used to describe plant communities are defined under "Climax Categories."

LITERATURE REVIEW

Daubenmire's (1970) habitat type approach to classification and inventory has become an established system (Pfister 1976, Mueggler and Stewart 1980, Moir and Hendzel 1983). His approach to identifying habitat types is based upon first studying the frequency and canopy coverage data of relatively stable, climax plant associations. Once the ecology and structure of these apparent climax associations have been studied, it is then determined to which climax a disturbed unit of vegetation belongs. A vegetation unit is considered climax if:

1. All young perennials that appeared successful in the community are represented by old individuals in the same stand;
2. Alien species are absent or represented by only a few plants of low vigor; and
3. Fire-sensitive species native to the area are not conspicuously absent.

Each type of climax is distinguished by close similarity in the dominants of all vegetation layers. However, minor species may be considered essential and may become a part of the habitat type name. Major single-layer dominants may be considered to have too broad a distribution to adequately separate out smaller units of greater ecological homogeneity. This is particularly true at the phase level where minor species are frequently used to separate habitat type phases.

In most disturbed vegetation, the trend is for secondary succession to progress toward the "original" primary climax vegetation. However, in areas where the native perennials have been eliminated or suppressed by heavy grazing or concentrated browsing, naturalized species such as *Bromus tectorum* and *Poa pratensis* are able to maintain dominance as zootic climax species (Daubenmire 1970). Gross productivity on zootic climaxes was found to be closely comparable to undisturbed climax stands.

Pfister (1976) reviewed the utility of the habitat type as a land classification unit for assessing landscape capability. Mueggler and Stewart (1980) classified the non-forested land of western Montana into 29 habitat types based upon potential natural vegetation and described the vegetation composition, distribution, and environment (including soils) of each habitat type. Tiedeman and Terwilliger (1978) used a method similar to habitat type classification in northwestern Colorado. The study emphasized that major differences in soils are as important as climax vegetation in the classification of landscape units. Their classification resulted in phyto-edaphic (plant-soil) units which are analogous to habitat types and range sites (Shiflet 1973). Moir and Hendzel (1983) coordinated a workshop that reviewed the concept and applications of habitat types in the Southwest, and Francis (1986) classified phyto-edaphic communities of a semiarid watershed that included potential natural vegetation.

STUDY AREA

Middle Park is a high mountain basin in north-central Colorado, approximately 160 km west of Denver (fig. 1).

Figure 1.—Shaded area represents the geographic location of Middle Park, Colorado.

It is bounded on the north by the Rabbit Ears Range, on the west and southwest by the Gore Range, and on the east and southeast by the Continental Divide, including the Front Range. The area includes approximately 600,000 ha of which approximately 100,000 ha is deer and elk winter range (Regelin 1976), and approximately 5,000 ha is critical winter range.

The vegetation aspect is dominated by big sagebrush (*Artemisia tridentata*) in most of the area at the lower elevations between 2,200 m and 2,750 m; aspen (*Populus tremuloides*) and conifers dominate at elevations above 2,750 m.

Precipitation in Middle Park is uniformly distributed throughout the year; about half falls as snow in winter. The average annual precipitation over a period of 41 years recorded at the Green Mountain Dam (2,361 m) was 39.9 cm; it was estimated at Kremmling (2,230 m) to average 35.6 cm (U.S. Department of Commerce 1977). Most of the critical winter range lies within this precipitation zone. Mean annual air temperature measured at the Green Mountain Dam averaged 4.6°C over the 41-year period.

METHODS

Geological maps (Izett 1968, Izett and Barclay 1973) and detailed soil maps (USDA Soil Conservation Service 1983)[3] were used to stratify the study area according to similar soils and geological material. A field reconnaissance study during the summer of 1977 was followed by a detailed study during the summer of 1978. Stands for quantitative description were located within each strata and selected to be free of apparent fire, excessive overgrazing, or other major disturbance.

The vegetation of each stand in the reconnaissance study was described using a modified layer and dominance rating (Oosting 1956) for each species present.[4]

The species layer ratings are:

Layer	Description
1	Ground layer, usually less than 7.5 cm tall.
2	The first layer above the ground layer consisting primarily of grasses and forbs.
3	The low shrub layer, including tall grasses and forbs less than 1.5 m above the soil surface.
4	The tall shrub layer greater than 1.5 m above the soil surface.
5	The tree layer.

The species dominance ratings are:

Dominance	Description
1	*Rare*—Species that can be seen only by searching for them in and around other plants. Species which occur in extremely wide-scattered and isolated patches would rate a dominance of 1 provided they did not represent an inclusion of a different plant community.
2	*Occasional*—Species that can be seen only by moving around in the stand or by looking intently while standing in one place. Species occurring in patches encountered only by moving about would be rated a dominance of 2 although within the patch the species may rate a higher dominance value.
3	*Common*—Species that are easily seen by standing in one place and looking casually around.
4	*Co-Dominant*—Species that are co-dominant in the aspect of the layer. This is the species that shares dominance with another or that is subordinant only to the layer dominant, which rates a 5. A layer may thus have one or more species rating a 4. In stands lacking an outstanding dominant, the two (or rarely more) most important species may be assigned a 4-dominance rating if they are approximately equal in their apparent impact on the micro-environment.
5	*Dominant*—Species that dominates the aspect of the layer. It is dominant in the sense of its impact on the micro-environment beneath its canopy. Some stands may not have a species that clearly rates a 5. In such cases, this class would not be used.

The physical characteristics of each stand in both reconnaissance and detailed studies were described in the field, including soil series, geologic material and formation, elevation, aspect, slope, position, relief, landform, physical disturbance, bare ground, and surface stones. Height of dominant species, intensity of grazing, and apparent successional stage were also described.

The stands from the reconnaissance study were grouped using association tables and defined as habitat types based upon similar floristic dominance, soils, and other environmental factors. The habitat types in the critical winter range were substantiated or altered as a result of detailed study the second summer. Habitat types outside the critical winter range were not studied further, and are subject to further study and refinement.

Six stands for each of nine habitat types were selected following reconnaissance. The criteria for selection were: least disturbed by fire, excessive grazing, flooding, or man; and the most representative of the habitat type. Vegetation was sampled for canopy cover and frequency using a minimum of thirty 20 x 50 cm plots. Species area curves (Cain 1938) were used on selected sample stands as a general guide to estimate the number of plots needed per site. The species area curve was designed to indicate the minimal number of plots to be sampled. In all cases the curve leveled off after 20 plots, which indicated that at least 30 plots would be adequate to include most

[3]*Soil maps used were completed at the time of this study but not published until 1983.*

[4]*The methodology was modified, but not published, by Dr. Charles Poulton, Oregon State University, Corvallis, Oregon.*

species present in the stand. The plots were spaced at three-pace intervals along two parallel transects; transects were 15 paces apart.

Species cover classes as described by Daubenmire (1970) were modified and estimated using 15 rather than 6 classes. The median values for the 15 modified cover classes used were: 0(0%), 1(1%), 2(2%), 3(3%), 4(4%), 10(5–15%), 20(15–25%), 30(25–35%), 40(35–45%), 50(45–55%), 60(55–65%), 70(65–75%), 80(75–85%), 90(85–95%), and 98(95–100%). Use of the median value in the field allowed rapid calculation of data to percent canopy cover. The 15 classes can be combined into the same 6 classes used by Daubenmire.

The number of species present in each stand was counted and recorded as species richness.

The heights of the first 30 shrubs per transect were measured and averaged to determine the height of the dominant layer. Current annual growth was excluded.

Erosion was described using a numerical Soil Surface Factor (SSF) (Clark 1980). A Soil Surface Factor less than 40 was classified as slight, 41–60 as moderate, and 61+ as severe erosion.

Soil temperature was measured at a depth of 50 cm or at a lithic or paralithic contact if less than 50 cm deep. Soil pits were dug to verify the soil series as mapped or to identify soil series that occurred as inclusions within the soil mapping unit as described in the Grand County soil survey (USDA Soil Conservation Service 1983).[3]

All species were identified according to Harrington (1964) except the species and subspecies of *Artemisia*, which were identified according to Beetle (1960) and Beetle and Young (1965).[5] Identification of *Artemisia tridentata* subspecies is difficult, but important for site classification. Different subspecies have different site requirements, management, and forage values. The subspecies *tridentata* is easily identified in moist bottomland sites where it usually reaches heights of 1.2 to 1.8 m. However, if it grows intermixed with the subspecies *wyomingensis* on uplands, the two may not be easily separated morphologically. The subspecies *vaseyana* may be identified and separated from the other two by its flat-topped growth form; also, its leaves fluoresce an intense blue color under ultraviolet light when crushed and placed in water (Stevens and McArthur 1974, McArthur et al. 1981). Of the hundreds of samples of *Artemisia* observed under black light in this study, only about 5–10% of the samples from *wyomingensis* communities fluoresced. On the other hand, 5% of the samples from the *vaseyana* communities did not fluoresce.

Most stands sampled have been grazed or browsed at various intensities. Grazing or browsing was subjectively rated for each sample stand according to three classes: slight, moderate, or severe based on degree of shrub hedging and evidence of utilization.

The vegetation of each stand was categorized according to the stage of succession. The classes used were: climax, stable, late seral, and early seral. A stand was considered climax using the previously mentioned criteria developed by Daubenmire (1970). A stand was considered stable if it met all the criteria for climax, and historical and current grazing or browsing was considered a factor in maintaining stability. The late seral class was used to describe a stand where all the dominant species of the climax community were present but reduced in cover or vigor, alien species were present but not dominating the site, and evidence of disturbance may have been apparent. The early seral class refers to stands where climax dominants are absent or poorly represented, alien species may dominate the site, established young perennial species are not represented by old individuals, fire-sensitive species may be absent or poorly represented, and there is obvious evidence of recent disturbance.

The habitat types were mapped on color aerial photographs[6] at a scale of 1:21,120. Mapping units were either single habitat types, or complexes of two or more habitat types that could not be delineated separately on the aerial photographs.

RESULTS AND DISCUSSION

A key is presented to aid in the identification of habitat types (Appendix). The key is based upon soil characteristics, position in the landscape, and dominant vegetation. It is recommended that vegetation, soils, and position in the landscape be used concurrently in the preliminary identification of the habitat types. Final identification of the habitat types should involve reference to the description of each habitat type and the section within each description titled, "Relation to other habitat types."

The habitat types within the critical mule deer winter range were studied in detail. Additional habitat types outside the area of the critical winter range were studied on a reconnaissance level only and are presented in a separate section.

Climax Categories

The stable vegetation of each habitat type is grouped into various climax categories (Daubenmire 1970). Climatic climaxes are those stable plant communities on deep, nonstony, moderately drained soils of gentle slope, primarily influenced by climatic factors. Edaphic climaxes are those where soils are sufficiently different to cause development of a significantly different climax. Climaxes that are restricted to special micro-climates, such as steep north facing slopes or sites where snow accumulates, are described as topographic climaxes. Topo-edaphic climax refers to the combining factors of topography and soils.

Livestock and wildlife grazing and browsing influence the development and maintenance of climax plant communities in Middle Park as do other factors of climate, topography, and soil. The history of grazing and browsing in Middle Park (Benedict 1975, Black 1969) is extensive enough to allow plant communities to reach a stable climax stage of succession.

[5]Voucher specimens are in the Colorado Division of Wildlife's herbarium, Kremmling, Colorado. Artemisia *sp. and ssp. were verified in the field and through laboratory analysis by Dr. Durant McArthur, USDA Forest Service, Shrub Sciences Lab., Provo, Utah.*

[6]Aerial photo maps on file at the Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico, and at the Colorado Division of Wildlife Office, Kremmling, Colorado.

Soils

On-site investigations found that more than one soil series frequently occurred within a habitat type, and more than one habitat type frequently occurred on the same soil series. Similar observations were reported in Washington by Daubenmire (1970), who concluded that, "those soil properties suspected of playing important roles in vegetation differentiation are not among the characters emphasized in soil classification."

Soils and vegetation develop from the same forming factors of climate, relief, organisms, parent material, and time; but soils do not respond to the same forming factors at the same proportional rate as vegetation. For this reason, a particular soil series may not always be directly correlated to a particular habitat type. For example, parent material may play a very important role in the classification of soils in an area, but may have only minor impact upon the plant association in comparison to some other factor, such as relief. On the other hand, since both soils and existing vegetation are influenced by the same forming factors, and are frequently correlated to some degree, both are useful in the identification of habitat types. In the identification and characterization of the habitat types in Middle Park, one soil series was selected as most representative (modal) for each habitat type, but other soils encountered were also listed in the habitat type description.

According to Hironaka, Fosberg, and Winward (1983) the correlation problem of a particular soil appearing to support more than a single habitat type could be resolved in most instances if the soils were separated at the soils series or phase level. They contend that the soils usually differ between two habitat types, even though differences may not be apparent. We believe that the soils do not necessarily differ, but recommend separating soil phases based upon habitat type. Tiedeman and Terwilliger (1978) believed that support by the same soil series of different climax plant associations was sufficient evidence for classifying them as two separate phyto-edaphic units. Francis (1986) speculated that the ecological amplitude of semi-arid species and the similarity of soils allow different plant communities to be supported by the same soil series, and the same plant community to grow on different soils.

Statistical Summaries

Mean species cover, standard error of the mean, percent frequency, and species richness for each individual stand in nine critical winter range habitat types and layer and dominance rating for eight other habitat types were summarized.[7] The standard error of the mean may be considered as a descriptive characteristic of a plant species within a plant community. A plant species with a contagious or clumped pattern of distribution will have a higher standard error in relation to the mean percent cover than a species with a regular or random distribution pattern. The variance to mean ratio has been used in other studies where a ratio greater than one is an indication of a contagious distribution (Greig-Smith 1983).

Frequency is the percent of the plots in a stand that contain a particular species. Species richness is the total number of different plant species in each sample stand. Species constancy is the number of stands (out of a possible six) in which the species listed was found to be present. Stand data were averaged by habitat type (tables 1 and 2).

More information can be gained from the vegetation summary tables about the plant community by observing both species cover and frequency together than either alone. For example, percent cover may be similar for two species, but the species with the higher frequency is more likely to be more evenly dispersed and to dominate or maintain itself within the plant community.

Phytomass was measured in 1978 and 1979 (Strong 1980) and summarized (table 3) according to graminoids, forbs, shrubs, and total phytomass for 10 habitat types within the critical winter range.

Phenological development of major species for the habitat types was studied during the spring and summer of 1978. Lower than normal rainfall during the growing season of the sample year prevented many species from developing beyond the vegetative stage.[8]

HABITAT TYPES WITHIN THE CRITICAL WINTER RANGE

Artemisia tridentata tridentata/Agropyron smithii h.t. (basin big sagebrush/western wheatgrass)

This is a topo-edaphic climax characterized by recent, dry alluvial stream terraces and upland swales where either lateral water flows or a water table exists at approximately 1.8 m in soil depth (fig. 2).

Artemisia tridentata subspecies *tridentata* dominates the overstory with an average height of 137 cm. The understory is sparse with *Agropyron smithii* dominant. The other most important species include *Sitanion hystrix*, *Chrysothamnus nauseosus* var. *glabratus*, *Penstemon caespitosus*, and moss (table 1).

The floristic description of this habitat type may vary significantly from that on landscapes in pristine condition. Most of the stands in this habitat type are dissected by a gully through the alluvial bottom. Such gullies will tend to make the site more xeric and discourage species requiring more moisture than sites in pristine condition. One typical species growing in such situations is *Elymus cinereus*. It was encountered at times on landscapes that were much more mesic than the average for this habitat type. In pristine conditions, this site would probably support an *Artemisia tridentata tridentata/Elymus cinereus* habitat type, but gullying and subsequent subsoil

[7] *Summarized stand data for the habitat types are available upon request from the authors.*

[8] *Terwilliger, Charles, Jr. and James A. Tiedeman. 1978. Habitat types of the mule deer critical winter range and adjacent steppe region of Middle Park, Colorado. 181 p. Final report, Cooperative Agreement No. 16-739-CA, Colorado State University in cooperation with USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, and the Colorado Division of Wildlife, Fort Collins.*

Figure 2.—*Artemisia tridentata tridentata/Agropyron smithii* h.t.

drainage has permanently changed the potential to different climax species.

Physical Characteristics

This habitat type occurs at elevations ranging from 2,250 m to 2,400 m. Slopes range from 0–20% at all aspects.

A number of soils support this habitat type, but the most representative is the Harsha series, a member of the fine-loamy, mixed family of Borollic Haplargids. Many of the soils within the habitat type have more weakly developed subsoils and more sand and gravel than the Harsha series. The parent material is recent alluvium from the surrounding residual material, including granite, gneiss, shale, and sandstone. Pierre shale is the major source of alluvium.

Relation to Other Habitat Types

The *Artemisia tridentata wyomingensis/Agropyron spicatum* habitat type differs in that it occurs on shallow gravelly soils, has a greater species richness including *Agropyron spicatum* and *Erigeron engelmanii*, and has *Chrysothamnus viscidiflorus* substituted for *Chrysothamnus nauseosus*.

The *Artemisia tridentata wyomingensis/Agropyron smithii* habitat type also occurs on deep soils, but on level terraces rather than concave swales and depressions. The average shrub height is much shorter, species richness is greater, and *Chrysothamnus viscidiflorus* occurs rather than *Chrysothamnus nauseosus*. The *Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii* habitat type is located on clayey, saline alluvial fans just above the recent alluvial terraces near sharply incised stream channels. Willow and cottonwoods occur on the current alluvial flood plain at the stream's edge below the terraces occupied by *Artemisia tridentata tridentata*.

Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii h.t. (black greasewood-basin big sagebrush/western wheatgrass)

This is a topo-edaphic climax characterized by clayey, saline, and alkaline soils on alluvial fans and toe slopes where salts accumulate as a result of leaching from surrounding areas (fig. 3). Overflow is a common occurrence that prevents *Sarcobatus vermiculatus* from maintaining a pure overstory dominance. Rapid overflow tends to leach out salt that has accumulated near the soil surface. *Artemisia tridentata* subspecies *tridentata* benefits from leaching, increasing in overstory composition after each major overflow. Eventually, *Sarcobatus vermiculatus* is able to regain dominance as it recycles salts to the soil surface. These salts inhibit *Artemisia tridentata* growth. This process is repeated again after each major overflow. The composition of these two species depends upon the time since the last overflow and the periodicity of overflow for each specific area. Species richness is low, with the most common species in the understory including *Agropyron smithii, Sitanion hystrix*, moss, and an unidentified black lichen (table 1).

Physical Characteristics

This habitat type occurs at elevations ranging from 2,200 m to 2,350 m. Slopes range from 0–20% at most aspects.

Most soils are clayey and saline as represented by the Harsha soil series, a member of the fine-loamy, mixed family of Borollic Haplargids. Other soils found within the habitat type are Binco clay loam and Leavitt loam. All soils contain secondary lime above the 100 cm depth. Parent material is usually alluvial fan deposits, primarily from Pierre shale of the Upper Cretaceous period.

Relation to Other Habitat Types

The *Artemisia tridentata tridentata/Agropyron smithii* habitat type is very similar except that *Sarcobatus ver-*

Figure 3.—*Sarcobatus vermiculatus-Artemisia tridentata tridentata/ Agropyron smithii* h.t.

Table 1.—Mean percent cover ± standard error of the mean ($\bar{X}$±SE), percent frequency (%F), constancy (C) and general characteristics of the *Artemisia tridentata tridentata/Agropyron smithii* = ARTRT/AGSM, *Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii* = SAVE-ARTRT/AGSM, *Artemisia tridentata wyomingensis/Agropyron smithii* = ARTRW/AGSM, *Artemisia tridentata wyomingensis/Agropyron spicatum* = ARTRW/AGSP, and *Agropyron spicatum/Artemisia frigida* = AGSP/ARFR habitat types within the critical winter range.

Species	Habitat Types									
	ARTRT/AGSM		SAVE-ARTRT/AGSM		ARTRW/AGSM		ARTRW/AGSP		AGSP/ARFR	
	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C
Graminoids:										
Agropyron smithii	3.52 ± .47	48•6	3.28 ± .46	29•6	8.94 ± .66	81•6	.20 ± .08	5•4	.10 ± .06	3•1
Agropyron spicatum	-	-	-	-	.02 ± .02	1•1	8.43 ± .90	61•6	14.42 ± 1.02	85•6
Bouteloua gracilis	-	-	.81 ± .32	5•1	.90 ± .26	14•4	1.42 ± .33	15•3	1.94 ± .39	18•4
Bromus anomalus	.05 ± .06	1•1	-	-	-	-	-	-	-	
Bromus spp.	.28 ± .14	3•1	-	-	-	-	-	-	-	
Carex geyeri	.28 ± .14	4•2	.02 ± .02	1•1	.24 ± .10	6•4	.39 ± .17	4•3	.02 ± .01	2•2
Elymus cinereus	07 ± .03	3•3	-	-	-	-	-	-	-	-
Juncus spp.	.06 ± .06	1•1	-	-	-	-	-	-	-	-
Koeleria cristata	.02 ± .02	1•1	.05 ± .06	1•1	.83 ± .25	9•2	1.60 ± .25	34•4	.98 ± .23	15•4
Oryzopsis hymenoides	.13 ± .08	2•3	.02 ± .02	1•2	.35 ± .18	5•2	.28 ± .18	1•1	.82 ± .29	8•3
Poa fendleriana	.07 ± .06	2•2	-	-	.17 ± .09	3•3	2.81 ± .38	34•4	.40 ± .14	5•2
Poa secunda	.02 ± .02	1•1	.03 ± .02	2•1	2.20 ± .38	26•5	.07 ± .05	1•1	.04 ± .03	2•2
Poa spp.	.46 ± .22	4•2	-	-	-	-	-	-	-	-
Sitanion hystrix	1.90 ± .31	32•6	2.05 ± .30	32•6	.91 ± .26	13•5	.44 ± .18	8•5	-	-
Stipa columbiana	-	-	-	-	-	-	-	-	.07 ± .03	3•1
Stipa comata	.22 ± .22	1•1	-	-	.47 ± .18	6•3	.84 ± .27	9•4	.11 ± .06	2•3
Stipa pinetorum	.01 ± .01	1•2	-	-	.42 ± .15	8•4	.21 ± .10	3•1	.19 ± .08	4•1
Forbs:										
Achillea lanulosa	.08 ± .06	2•1	-	-	-	-	-	-	-	-
Agoseris glauca	-	-	-	-	-	-	.03 ± .02	2•1	.11 ± .04	6•4
Antennaria parvifolia	-	-	-	-	.15 ± .16	1•1	.64 ± .23	5•1	.08 ± .06	2•2
Arnica cordifolia	-	-	.12 ± .06	4•1	-	-	-	-	-	-
Artemisia dracunculus	-	-	-	-	-	-	.04 ± .05	1•1	.01 ± .01	1•1
Artemisia ludoviciana	-	-	-	-	-	-	-	-	.32 ± .18	4•1
Aster spp.	.90 ± .24	12•1	.08 ± .06	2•1	-	-	-	-	-	-
Astragalus flexuosus	1.50 ± .57	7•1	-	-	-	-	-	-	-	-
Astragalus shortianus	-	-	-	-	-	-	-	-	.11 ± .04	5•4
Balsamorhiza sagittata	-	-	-	-	-	-	-	-	.13 ± .08	2•1
Chaenactis douglasii	-	-	-	-	-	-	-	-	.02 ± .02	2•1
Chrysopsis villosa	-	-	-	-	-	-	-	-	.68 ± .26	8•3
Commandra umbellata	-	-	-	-	-	-	-	-	.02 ± .01	2•2
Crepis acuminata	-	-	-	-	-	-	-	-	.05 ± .02	3•1
Delphinium nelsonii	-	-	-	-	-	-	-	-	.47 ± .15	6•1
Erigeron compositus	-	-	-	-	-	-	-	-	.67 ± .16	14•1
Erigeron eatonii	-	-	.08 ± .06	2•1	-	-	.11 ± .05	4•3	.01 ± .01	1•1
Erigeron engelmanii	-	-	-	-	.01 ± .01	1•1	.20 ± .04	10•6	.31 ± .06	17•5
Eriogonum brevicaule	-	-	.05 ± .06	1•1	-	-	-	-	.15 ± .12	1•1
Eriogonum umbellatum	-	-	-	-	1.42 ± .26	25•4	.24 ± .09	7•3	.01 ± .01	1•1
Haplopappus nuttallii	-	-	-	-	-	-	-	-	.77 ± .17	17•3
Hymenopappus filifolius	-	-	-	-	-	-	-	-	.71 ± .18	15•3
Lappula sp.	-	-	-	-	-	-	-	-	.02 ± .02	1•1

Linum lewisii	-	-	-	-	-	-	-	-	.20 ± .08	6•2
Mammillaria vivipara	-	-	.03 ± .02	2•3	.09 ± .04	4•4	.13 ± .06	5•4	-	-
Mertensia ciliata	.01 ± .01	1•1	-	-	.01 ± .01	1•1	-	-	.02 ± .01	1•2
Mertensia lanceolata	.09 ± .04	4•2	-	-	-	-	.46 ± .11	14•2	.25 ± .09	8•3
Opuntia polyacantha	-	-	.13 ± .11	1•1	.02 ± .02	1•1	.01 ± .02	1•1	.05 ± .05	1•1
Oxytropis sericea	-	-	.03 ± .03	1•1	-	-	.05 ± .02	3•1	.01 ± .01	1•1
Penstemon caespitosus	.37 ± .19	4•6	1.08 ± .36	9•3	.25 ± .13	4•3	.04 ± .05	1•1	1.66 ± .26	34•4
Penstemon strictus	.01 ± .01	1•1	-	-	.02 ± .01	1•1	-	-	.01 ± .02	1•1
Phlox bryoides	-	-	.41 ± .12	8•3	4.79 ± .49	59•6	1.69 ± .23	31•3	4.27 ± .37	60•5
Phlox multiflora	-	-	.05 ± .06	1•1	-	-	1.20 ± .21	18•3	.01 ± .01	1•1
Phlox sp.	-	-	-	-	-	-	-	-	.46 ± .17	5•1
Physaria acutifolia	-	-	-	-	-	-	-	-	.04 ± .03	2•1
Physaria sp.	-	-	-	-	-	-	.01 ± .01	1•1	.01 ± .01	2•1
Potentilla concinna	.02 ± .02	1•2	-	-	-	-	-	-	.02 ± .02	1•1
Potentilla hippiana	-	-	-	-	-	-	-	-	.13 ± .06	3•2
Sedum stenopetalum	-	-	-	-	-	-	.01 ± .01	1•1	-	-
Senecio canus	-	-	-	-	-	-	-	-	.05 ± .02	3•3
Senecio multilobatus	-	-	-	-	-	-	-	-	.04 ± .02	2•2
Sphaeralcea coccinea	-	-	.01 ± .01	1•1	-	-	.02 ± .02	1•2	.17 ± .06	8•2
Townsendia sp.	-	-	-	-	-	-	.03 ± .02	1•1	.02 ± .01	2•1
Trifolium gymnocarpon	-	-	-	-	.01 ± .01	1•1	.50 ± .12	14•3	.05 ± .03	2•1
BLACK LICHEN	-	-	3.26 ± .62	31 ± 6	.27 ± .07	14•4	-	-	-	-
LICHEN	.23 ± .12	7•4	1.01 ± .32	14•4	1.51 ± .20	46•5	1.50 ± .27	38•4	1.73 ± .20	52•5
MOSS	8.00 ± 1.31	28•6	.61 ± .25	9•6	3.02 ± .61	24•4	1.36 ± .39	14•1	.23 ± .10	4•2
MUSTARD	.01 ± .01	1•1	.01 ± .01	1•1	-	-	-	-	.02 ± .01	2•2
OTHER FORBS	.36 ± .19	6•1	-	-	-	-	.11 ± .07	2•1	.07 ± .03	3•1
Shrubs:										
Amelanchier alnifolia	-	-	-	-	-	-	.04 ± .05	1•1	-	-
Artemisia cana	.44 ± .44	1•1	-	-	-	-	-	-	-	-
Artemisia frigida	-	-	.26 ± .09	7•1	.50 ± .15	11•4	.33 ± .10	8•4	1.55 ± .21	34•6
Artemisia tridentata tridentata	34.04 ± 2.05	92•6	20.59 ± 1.68	67•6	-	-	-	-	-	-
Artemisia tridentata wyomingensis	-	-	-	-	24.95 ± 1.67	83•6	19.71 ± 1.68	72•6	1.99 ± .50	15•2
Chrysothamnus nauseosus var. *glabratus*	7.15 ± 1.30	26•5	1.17 ± .40	7•1	-	-	.01 ± .02	1•1	-	-
Chrysothamnus parryi var. *attenuatus*	-	-	-	-	-	-	.09 ± .10	1•1	2.14 ± .59	13•4
Chrysothamnus viscidiflorus var. *viscidiflorus*	-	-	-	-	2.94 ± .47	31•5	1.56 ± .35	16•6	1.27 ± .31	14•3
Eurotia lanata	-	-	.86 ± .24	9•3	.01 ± .01	1•1	-	-	-	-
Purshia tridentata	-	-	-	-	-	-	.33 ± .33	1•1	-	-
Ribes cereum	.05 ± .06	1•1	-	-	-	-	-	-	-	-
Salix sp.	.05 ± .06	1•1	-	-	-	-	-	-	-	-
Sarcobatus vermiculatus	-	-	9.85 ± 1.42	36•6	-	-	-	-	-	-
Tetradymia canescens	-	-	.06 ± .06	1•1	-	-	-	-	-	-
Xanthocephalum sarothrae	-	-	-	-	-	-	-	-	1.80 ± .36	19•2
General Characteristics:										
BARE GROUND	46.03 ± 2.36	92•6	61.31 ± 1.84	99•6	50.38 ± 1.62	99•6	56.55 ± 1.94	99•6	63.00 ± 1.25	99•6
LITTER	28.43 ± 1.54	94•6	13.89 ± .92	97•6	8.13 ± .65	77•5	4.79 ± .66	41•3	2.46 ± .25	65•5
TOTAL PERCENT COVER	60.58 ± 3.14		46.13 ± 2.15		55.53 ± 2.13		48.10 ± 2.08		42.53 ± 1.34	
SPECIES RICHNESS	33		30		31		40		62	

Table 2.—Mean percent cover ± standard error of the mean ($\bar{X}$±SE), percent frequency (%F), constancy (C) and general characteristics of the *Juniperus scopulorum/Agropyron spicatum* = JUSC/AGSP, *Artemisia tridentata vaseyana/Festuca idahoensis* = ARTRV/FEID, *Amelanchier alnifolia/Agropyron spicatum* = AMAL/AGSP, and *Amelanchier alnifolia/Carex* = AMAL/CAREX habitat types within the critical winter range.

	Habitat Types							
	JUSC/AGSP		ARTRV/FEID		AMAL/AGSP		AMAL/CAREX	
Species	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C
Graminoids:								
Agropyron smithii	–	–	.44 ± .13	10•1	.15 ± .09	2•1	–	–
Agropyron spicatum	7.72 ± 1.03	46•6	.34 ± .11	8•5	17.48 ± 1.42	77•6	1.96 ± .41	18•5
Agropyron spp.	–	–	.32 ± .13	7•1	–	–	.98 ± .27	8•2
Agrostis scabra	–	–	–	–	–	–	.14 ± .08	2•1
Bouteloua gracilis	.55 ± .21	5•5	–	–	–	–	–	–
Bromus anomalus	–	–	–	–	–	–	.45 ± .23	7•4
Bromus spp.	–	–	.82 ± .19	14•3	–	–	–	–
Bromus tectorum	.13 ± .11	3•1	–	–	–	–	–	–
Carex geyeri	3.35 ± .63	25•5	3.20 ± .57	27•3	–	–	–	–
Carex spp.	–	–	.11 ± .07	2•2	–	–	3.51 ± .64	22•4
Festuca idahoensis	.05 ± .05	1•1	2.67 ± .37	31•4	–	–	3.51 ± .64	22•4
Koelaria cristata	.33 ± .12	6•4	1.76 ± 30	24•5	.01 ± .01	1•1	1.15 ± .32	11•4
Oryzopsis hymenoides	2.58 ± .62	18•6	.01 ± .01	1•1	1.78 ± .39	18•4	.05 ± .05	1•1
Oryzopsis micrantha	.60 ± .29	4•2	–	–	–	–	–	–
Poa fendleriana	1.42 ± .31	15•4	7.29 ± .74	53•6	.11 ± .11	1•2	2.31 ± .46	18•5
Poa nevadensis	–	–	.27 ± .18	2•1	–	–	.16 ± .16	1•1
Poa pratensis	–	–	.01 ± .01	1•1	–	–	.35 ± .12	5•3
Poa secunda	.13 ± .08	3•1	–	–	–	–	–	–
Poa spp.	.05 ± .05	1•1	.02 ± .02	1•1	–	–	–	–
Sitanion hystrix	1.05 ± .35	13•6	.87 ± .20	15•4	–	–	.22 ± .10	4•5
Stipa comata	–	–	–	–	–	–	.03 ± .02	1•1
Stipa pinetorum	.11 ± .04	4•3	1.38 ± .31	14•3	–	–	.02 ± .02	1•1
Forbs:								
Achillea lanulosa	–	–	–	–	–	–	.11 ± .04	5•4
Agoseris glauca	–	–	.02 ± .02	1•1	.03 ± .02	2•1	–	–
Androsace septentrionalis	.02 ± .02	1•1	.10 ± .06	3•2	–	–	–	–
Antennaria anaphaloides	–	–	–	–	–	–	.11 ± .06	3•2
Antennaria parvifolia	.06 ± .05	1•2	.76 ± .10	11•5	–	–	.48 ± .22	5•3
Arnica cordifolia	–	–	–	–	–	–	.01 ± .01	1•1
Artemisia ludoviciana	–	–	–	–	.07 ± .06	1•2	–	–
Astragalus shortianus	–	–	–	–	.02 ± .02	1•1	–	–
Balsamorhiza sagittata	.15 ± .09	2•1	–	–	.03 ± .02	1•1	1.23 ± .38	13•2
Castilleja flava	–	–	.18 ± .08	4•2	.38 ± .15	6•3	.01 ± .01	1•1
Chaenactis douglasii	–	–	–	–	.03 ± .02	2•2	–	–
Chenopodium spp.	.01 ± .01	1•2	–	–	–	–	–	–
Chrysopsis villosa	.07 ± .05	2•1	.01 ± .01	1•1	–	–	–	–
Cirsium spp.	–	–	–	–	–	–	.08 ± .06	2•1
Clematis hirsutissima	–	–	.35 ± .16	3•2	–	–	.68 ± .22	8•2
Clematis pseudoalpina	–	–	–	–	–	–	.59 ± .24	6•1
Commandra umbellata	.02 ± .02	1•1	–	–	–	–	.01 ± .01	1•1
Crepis acuminata	.02 ± .02	1•1	.02 ± .02	1•1	.03 ± .02	1•1	–	–
Cryptantha sericea	–	–	–	–	.04 ± .03	2•2	–	–
Delphinium nelsonii	.13 ± .06	3•1	–	–	.28 ± .11	5•3	.23 ± .11	3•1
Delphinium occidentale	–	–	–	–	1.14 ± .24	16•4	–	–
Desurania richardsonii	.06 ± .03	2•3	–	–	–	–	–	–
Erigeron eatonii	.01 ± .01	1•1	.05 ± .03	2•2	–	–	.12 ± .06	3•4
Erigeron engelmanii	–	–	.15 ± .06	6•3	.01 ± .01	1•1	.06 ± .05	1•2
Erigeron speciosus	–	–	.01 ± .01	1•1	–	–	1.07 ± .30	9•4
Eriogonum umbellatum	–	–	3.49 ± .77	25•6	.35 ± .22	3•1	3.79 ± .76	26•5
Euphorbia robusta	–	–	–	–	.02 ± .02	1•1	–	–
Galium boreale	–	–	–	–	–	–	1.48 ± .30	21•5
Geum triflorum	–	–	–	–	–	–	.01 ± .01	1•1
Gilia candida	–	–	–	–	.02 ± .01	2•2	–	–
Haplopappus armeroides	–	–	.05 ± .05	1•1	–	–	–	–
Heuchera parvifolia	.05 ± .03	2•2	.20 ± .09	3•1	–	–	.76 ± .16	17•5
Linum lewisii	.01 ± .01	1•1	–	–	.12 ± .08	2•3	–	–
Lupinus ammophilus	.03 ± .03	1•1	2.65 ± .59	21•3	.25 ± .21	2•1	.36 ± .11	8•1
Lupinus greenii	–	–	.61 ± .20	8•2	–	–	2.27 ± .56	20•4
Mammillaria vivipara	.02 ± .02	1•1	–	–	–	–	–	–

Table 2.—Mean percent cover ± standard error of the mean ($\bar{X} \pm SE$), percent frequency (%F), constancy (C) and general characteristics of the *Juniperus scopulorum*/*Agropyron spicatum* = JUSC/AGSP, *Artemisia tridentata vaseyana*/*Festuca idahoensis* = ARTRV/FEID, *Amelanchier alnifolia*/*Agropyron spicatum* = AMAL/AGSP, and *Amelanchier alnifolia*/*Carex* = AMAL/CAREX habitat types within the critical winter range.—Continued

	Habitat Types							
	JUSC/AGSP		ARTRV/FEID		AMAL/AGSP		AMAL/CAREX	
Species	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C	$\bar{X}$±SE	%F•C
Forbs:								
Mertensia ciliata	.02 ± .01	2•2	-	-	.01 ± .01	1•2	-	-
Mertensia lanceolata	1.13 ± .19	23•5	3.66 ± .34	59•6	.06 ± .03	3•3	.15 ± .04	8•1
Opuntia polyacantha	.32 ± .27	2•2	-	-	-	-	-	-
Penstemon caespitosus	.02 ± .02	1•1	.64 ± .28	6-2	-	-	.02 ± .02	1•1
Penstemon strictus	-	-	-	-	.01 ± .01	1•1	-	-
Penstemon watsonii	.08 ± .06	3•2	.09 ± .06	3•3	-	-	.16 ± .11	3•3
Phlox bryoides	.03 ± .03	1•1	.04 ± .02	2•2	-	-	-	-
Phlox multiflora	-	-	1.53 ± .23	26•4	-	-	.77 ± .22	11•3
Physaria acutifolia	-	-	.04 ± .02	2•2	-	-	-	-
Physaria sp.	-	-	.11 ± .06	4•3	.10 ± .06	3•3	-	-
Potentilla concinna	.34 ± .17	3•3	.05 ± .05	1•1	-	-	.06 ± .02	3•2
Potentilla hippiana	-	-	.26 ± .10	6•2	-	-	-	-
Senecio canus	-	-	-	-	.02 ± .02	1•1	-	-
Senecio multilobatus	.21 ± .08	6•5	.01 ± .01	1•1	.01 ± .01	1•1	-	-
Taraxacum officinale	-	-	.12 ± .04	6•3	.13 ± .08	3•2	.01 ± .01	2•2
Trifolium gymnocarpon	-	-	.36 ± .10	12•4	-	-	-	-
Vicia americana	-	-	.51 ± .26	4•2	-	-	-	-
Wyethia arizonica	-	-	-	-	-	-	.11 ± .11	1•1
LICHEN	.41 ± .12	9•1	.32 ± .09	12•2	.01 ± .01	1•1	.03 ± .01	2•1
MOSS	.08 ± .06	2•1	.02 ± .02	1•1	-	-	-	-
MUSTARD	.10 ± .04	6•4	.93 ± .30	12•3	.18 ± .09	3•1	.10 ± .06	2•2
Shrubs:								
Amelanchier alnifolia	-	-	-	-	16.20 ± 2.13	37•6	44.08 ± 2.59	81•6
Artemisia frigida	.07 ± .06	2•1	.05 ± .05	1•1	.24 ± .13	3•3	-	-
Artemisia tridentata vaseyana	-	-	24.63 ± 1.57	87•6	-	-	2.48 ± .63	14•6
Artemisia tridentata wyomingensis	4.35 ± .90	20•5	-	-	2.35 ± .73	9•3	-	-
Berberis repens	-	-	-	-	-	-	.02 ± .02	1•2
Cercocarpus montanus	-	-	-	-	1.72 ± .63	7•2	.85 ± .35	6•3
Chrysothamnus nauseosus var. *glabratus*	- -	-		.27 ± .18	2•1	-	-	-
Chrysothamnus parryi var. *attenuatus*	.21 ± .13	2•3	-	-	.96 ± .37	5•4	-	-
Chrysothamnus viscidiflorus var. *viscidiflorus*	.05 ± .05	1•1	3.36 ± .59	32•6	.24 ± .17	2•2	1.13 ± .34	9•6
Juniperus communis	-	-	-	-	-	-	.11 ± .11	1•1
Juniperus scopulorum	23.14 ± 2.30	49•6	-	-	-	-	-	-
Pachystima myrsinites	-	-	-	-	-	-	.43 ± .16	6•2
Prunus virginiana	-	-	-	-	1.15 ± .40	6•1	.20 ± .12	2•2
Purshia tridentata	.18 ± .12	2•2	-	-	.61 ± .28	4•2	.94 ± .50	3•3
Rhus trilobata	-	-	-	-	.42 ± .42	1•1	-	-
Ribes cereum	.67 ± .28	5•4	-	-	.18 ± .12	2•2	.11 ± .11	1•1
Rosa sp.	-	-	-	-	-	-	.56 ± .20	6•2
Symphoricarpos oreophilus	.16 ± .16	1•2	.61 ± .19	8•5	4.28 ± .69	28•6	17.59 ± 1.31	79•6
General Characteristics:								
BARE GROUND	71.40 ± 1.73	100•5	26.80 ± 1.80	91•6	50.95 ± 2.47	88•6	1.54 ± .36	18•6
LITTER	100.00 ± 1.00	71•5	9.59 ± .92	59•4	12.65 ± 1.43	81•6	14.38 ± 1.11	90•6
TOTAL PERCENT COVER	51.36 ± 2.75		67.22 ± 2.18		52.79 ± 2.59		137.30 ± 2.82	
SPECIES RICHNESS	46		55		46		61	

miculatus is absent, and it occupies the sandier, nonsaline stream terraces. The *Artemisia tridentata wyomingensis*/*Agropyron smithii* habitat type also occurs on soils of the Harsha series, but its soils are less saline or alkaline and *Chrysothamnus viscidiflorus* var. *viscidiflorus* is present. These differences should be sufficient to classify two phases of the Harsha series.

Artemisia tridentata wyomingensis/ Agropyron smithii h.t (Wyoming big sagebrush/western wheatgrass)

This habitat type is a climatic climax characterized by an overstory of *Artemisia tridentata* subsp. *wyomingensis* with an average height of 38 cm (fig. 4). The understory is dominated by *Agropyron smithii*. Other important members of the community include: *Phlox bryoides*, *Poa secunda*, *Sitanion hystrix*, *Bouteloua gracilis*, *Stipa pinetorum*, and *Chrysothamnus viscidiflorus* var. *viscidiflorus* (table 1).

Physical Characteristics

This habitat type occurs at elevations ranging from 2,200 m to 2,300 m. Slopes are not usually steeper than 20% with no dependency upon aspect. The topographic position is undulating terrace and plateau tops. Bare ground occupies about 50% of the area (table 1).

Figure 4.—*Artemisia tridentata wyomingensis/Agropyron smithii* h.t.

The major soil that supports this habitat type is represented by the Harsha series, a member of the fine-loamy, mixed family of Borollic Haplargids. This series as currently defined supports several habitat types. Other soils include the Leavitt series, which has darker surface soil colors. The parent material is primarily loess and basin filled fine textured material of terrace deposits that overlay the recent floodplain and Troublesome Formation.

Table 3—Graminoid, forb, shrub, and total phytomass for ten habitat types within the critical winter range listed from lowest to highest total phytomass (Strong 1980). Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test (Steel and Torrie 1980).

	Mean Phytomass (kg/ha)			
	Graminoid	Forb	Shrub	Total
Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule habitat type	12a	15a	78a	107
Juniperus scopulorum/Agropyron spicatum habitat type	171bc	49ab	164a	399a
Agropyron spicatum/Artemisia frigida habitat type	261cd	152cd	132a	559ab
Amelanchier alnifolia/Agropyron spicatum habitat type	175bc	71abc	336ab	606abc
Artemisia tridentata wyomingensis/ Agropyron smithii habitat type	79ab	27a	737c	877bc
Artemisia tridentata wyomingensis/ Agropyron spicatum habitat type	193bc	73abc	565bc	904c
Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii habitat type	30a	6a	1360de	1417d
Artemisia tridentata vaseyana/ Festuca idahoensis habitat type	164bc	121bcd	1072d	1427d
Artemisia tridentata tridentata/ Aropyron smithii habitat type	149bc	33a	1468c	1655de
Amelanchier alnifolia/Carex habitat type	371d	169d	1405e	1959e

Relation to Other Habitat Types

The *Artemisia tridentata vaseyana/Festuca idahoensis* habitat type also occurs on deep soils, but they are darker colored mollisols at higher elevations where the environment is cooler and more mesic. Bare ground occupies half as much area. Species richness is much greater for this higher elevation habitat type and includes species that require more moisture such as *Phlox multiflora, Symphoricarpos oreophilus, Festuca idahoensis, Lupinus* species, *Mertensia lanceolata*, and *Poa fendleriana*. These species do not occur significantly in the *Artemisia tridentata wyomingensis/Agropyron smithii* habitat type.

The *Artemisia tridentata wyomingensis/Agropyron spicatum* habitat type differs in that it is specific to shallow gravelly soils on steeper upland positions. *Agropyron spicatum* rather than *Agropyron smithii* dominates the understory.

The *Artemisia tridentata tridentata/Agropyron smithii* habitat type occurs on recent stream terraces and swale positions. *Phlox bryoides* is absent and *Chrysothamnus nauseosus* is present rather than *Chrysothamnus viscidiflorus*.

The *Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii* habitat type occurs on toe slopes of saline and alkaline soils, and *Chrysothamnus viscidiflorus* var. *viscidiflorus* is absent.

Artemisia tridentata wyomingensis/ Agropyron spicatum h.t. (Wyoming big sagebrush/bluebunch wheatgrass)

This is an edaphic climax specific to gravelly soils. The overstory is dominated by *Artemisia tridentata wyomingensis* that averages 36 cm in height (fig. 5). The understory is dominated by *Agropyron spicatum*. Other important members of the plant community include *Chrysothamnus viscidiflorus* var. *viscidiflorus, Poa fendleriana*, and *Erigeron engelmanii* (table 1).

Physical Characteristics

This habitat type occurs at elevations ranging from 2,300 m to 2,500 m. Slopes range from 0–65% on primarily south- to west-facing slopes. This habitat type is usually located on sloping uplands, ridges, and gravelly outwash terraces.

Figure 5.—*Artemisia tridentata wyomingensis/Agropyron spicatum* h.t.

Most soils are gravelly as represented by the Quander series, a member of the loamy-skeletal, mixed family of Argic Cryoborolls. Quander is the major soil series supporting this habitat type. Other soils include the Tine series, which is sandier, and the Leavitt and Waybe series, which contain less gravel. The parent material is usually gravelly outwash terrace or residual gneiss, granite, or sandstone. Geologic formations include Pierre Shale with a sandstone cap and Boulder Creek granodiorite.

Relation to Other Habitat Types

The *Artemisia tridentata vaseyana/Festuca idahoensis* habitat type occurs at higher elevations and in swale positions where soil temperatures are colder and snow accumulation is greater, resulting in a more mesic environment. The moisture-indicating species such as *Lupinus* species and *Vicia americana* do not usually occur in the *Artemisia tridentata wyomingensis/Agropyron spicatum* habitat type.

Agropyron spicatum/Artemisia frigida h.t. (bluebunch wheatgrass/fringed sagebrush)

This is a topographic climax specific to windswept ridge tops. *Artemisia tridentata* is absent or less than 13 cm tall (fig. 6). The most important species of this community are *Agropyron spicatum, Artemisia frigida, Phlox bryoides, Penstemon caespitosus, Erigeron engelmanii, Bouteloua gracilis* and lichen (table 1).

Physical Characteristics

This habitat type occurs at elevations ranging from 2,250 m to 2,500 m. It occupies gravelly, windblown ridgetop positions and windward-facing slopes, ranging from 0–65%, mostly on south and west exposures.

Figure 6.—*Agropyron spicatum/Artemisia frigida* h.t.

Soils within this habitat type are mostly gravelly, as represented by the Rogert series, a member of the loamy-skeletal, mixed family of Lithic Cryoborolls. The Quander and Tine series also support this habitat type and are gravelly (skeletal) soils. Parent material is residual from local granite or gneiss rock or cobbly outwash from old river terraces. The geologic formation and materials include Boulder Creek Granodiorite, quartz Monzonite, Middle Park formation, and hornblende gneiss.

Relation to Other Habitat Types

This type often occurs in a complex pattern with the *Artemisia tridentata wyomingensis/Agropyron spicatum* habitat type. The vegetation composition is similar except that *Artemisia tridentata* is usually absent, or when present, it usually grows in a prostrate form rarely reaching a height over 13 cm, always inferior in height to *Agropyron spicatum. Sitanion hystrix* and *Phlox multiflora* are usually absent.

Artemisia tridentata tridentata/Agropyron smithii habitat type occurs on the sandier stream terrace positions and swale positions near intermittent streams at low elevations. *Artemisia tridentata wyomingensis/Agropyron smithii* habitat type occurs on the deep, nongravelly soils usually developed from the Troublesome Formation; *Agropyron spicatum* is rarely present.

Juniperus scopulorum/Agropyron spicatum h.t. (Rocky Mountain juniper/bluebunch wheatgrass)

This is an edaphic climax specific to cobbly and stony soils with extensive areas of rock outcropping (fig. 7). Some of the most important species in the plant association include *Oryzopsis hymenoides, Carex* spp., *Mertensia lanceolata, Sitanion hystrix, Artemisia tridentata* subsp. *wyomingensis*, and *Bouteloua gracilis* (table 2).

Physical Characteristics

This habitat type occurs at elevations ranging from 2,300 m to 2,550 m. It occupies steep rocky and stony ridges and mountain slopes ranging from 35–70% with mostly south and west facing exposures. Bare ground or rock occupy over 70% of the area (table 1). Runoff from rocky areas increases the effective moisture in surrounding areas where moisture loving species may be found.

The major soils are Cryoborolls associated with rock outcrops. Parent material is usually gneiss or granodiorite residium and alluvium, from Boulder Creek Granodiorite, biotite gneiss, or quartz Monzonite geologic material.

The *Juniperus scopulorum/Agropyron spicatum* habitat type has been disturbed by fire and heavily browsed by deer.

Relation to Other Habitat Types

The *Amelanchier alnifolia/Agropyron spicatum* habitat type is very similar except for the exclusion of *Juniperus scopulorum, Bouteloua gracilis, Carex* spp., and *Sitanion hystrix*. It is more specific to stony, alluvial slopes with less rock outcroppings, although both occupy rocky landscapes.

Artemisia tridentata vaseyana/Festuca idahoensis h.t. (mountain big sagebrush/Idaho fescue)

This is a climatic climax characterized by a dense overstory of *Artemisia tridentata* subsp. *vaseyana* that averages 58 cm in height (fig. 8). The associated understory includes a number of moisture-indicating species that comprise the *Festuca idahoensis* union (table 2). Members of this union include *Festuca idahoensis, Carex* spp., *Lupinus* spp., *Castilleja flava, Taraxacum officinale, Huechera parvifolia, Clematis hirsutissima, Vicia americana, Potentilla hippiana, Androsace septentrionalis*, and *Symphoricarpos oreophilus. Chrysothamnus viscidiflorus* var. *viscidiflorus, Mertensia lanceolata, Poa fendleriana*, and *Trifolium gymnocarpon* are important species but are not included as members of the *Festuca idahoensis* union. A union is used here to represent a group of plant species that commonly occur together, but none of which distinctively dominates the layer, and all of which are useful for classification purposes. Not all members of the union, including *Festuca idahoensis*, need to be present. Heavy

Figure 7.—*Juniperus scopulorum/Agropyron spicatum* h.t.

Figure 8.—*Artemisia tridentata vaseyana/Festuca idahoensis* h.t.

grazing may reduce the understory species composition to a dominance of *Poa fendleriana* or *Sitanion hystrix*.

Physical Characteristics

This habitat type occurs at elevations ranging from 2,350 m to 2,700 m. Slopes range from 0–20% at lower elevations, with mostly north- to east-facing slopes. At higher elevations, this habitat type is usually on steeper south- and west-facing slopes. It occupies swale positions and shallow snow drift areas at the lower elevations, but occupies plateaus of deep soils as a climatic climax at the higher elevations.

The major soils that support this habitat type are represented by Leavitt loam, a member of the fine-loamy, mixed family of Argic Cryoborolls. The Quander soil series also supports this habitat type at the higher elevations. Quander soils are more gravelly than Leavitt soils. Parent material is usually local loess over decomposed shale bedrock from the Pierre Shale of Late Cretaceous age.

Relation to Other Habitat Types

The *Artemisia tridentata wyomingensis/Agropyron spicatum* habitat type occurs near this type on the dryer gravelly soils at the lower elevations. In the complex micro-relief pattern of undulating topography, *Artemisia tridentata wyomingensis* occurs on convex hummocks while *Artemisia tridentata vaseyana* occurs on concave depressions. Members of the *Festuca idahoensis* union are usually absent from the *Artemisia tridentata wyomingensis* habitat types, especially *Festuca idahoensis*, *Lupinus* spp., *Castilleja flava*, and *Symphoricarpos oreophilus*. *Amelanchier alnifolia/Carex* has a similar soil, but it is restricted to areas of deep snow drift accumulation.

Amelanchier alnifolia/Agropyron spicatum h.t. (serviceberry/bluebunch wheatgrass)

This is an edaphic climax specific to cobbly and stony soils. *Amelanchier alnifolia* dominates the overstory canopy, averaging 135 cm in height. The associated understory is dominated by *Agropyron spicatum* (fig. 9). Other important members of the association include *Symphoricarpos oreophilus*, *Chrysothamnus parryi* var. *attenuatus*, *Oryzopsis hymenoides*, and *Delphinium occidentale* (table 2).

Physical Characteristics

This habitat type occurs at elevations from 2,400 m to 2,600 m. Slopes range from 30–70% primarily on south- and west-facing exposures. It occupies steep cobbly and gravelly mountain slopes. About 50% of the ground surface is bare (table 2).

Figure 9.—***Amelanchier alnifolia/Agropyron spicatum*** **h.t.**

The major soil that supports this type is represented by Rogert gravelly sandy loam, a member of the loamy-skeletal, mixed family of Lithic Cryoborolls. Although the representative profile is lithic, much of the soil is deeper than 50 cm to hard bedrock. Parent material is mostly colluvium from Boulder Creek Granodiorite of Precambrian age.

Relation to Other Habitat Types

The *Juniperus scopulorum/Agropyron spicatum* habitat type occurs in very similar landscapes, but occupies rockier residual soil material. Not only *Juniperus* but also *Carex*, *Bouteloua gracilis*, and *Sitanion hystrix* are absent from the *Amelanchier alnifolia/Agropyron spicatum* habitat type. The *Amelanchier alnifolia/Carex* habitat type differs greatly in that it has deep Mollic soils, very few cobbles or stones, a continuous ground cover, and occupies moist snow drift areas. Species richness is much higher, including moisture-loving species as *Carex* spp., *Festuca idahoensis*, *Erigeron speciosus*, *Galium boreale*, *Heuchera parvifolia*, and *Lupinus* spp.

Aspen (*Populus tremuloides*) occupies sites where increased elevation or a change in relief would allow greater snow accumulation. Douglas-fir (*Pseudotsuga menziesii*) forest occurs on gravelly sites similar to the *Amelanchier alnifolia/Agropyron spicatum* habitat type, but at higher elevations or north-facing slopes.

Amelanchier alnifolia/Carex h.t. (serviceberry/sedge)

This is a topographic climax restricted to snow drift accumulation sites on north- and east-facing slopes. *Amelanchier alnifolia* dominates the overstory, averaging about 200 cm in height (fig. 10). The associated understory is usually dominated by *Carex* spp. and members of the *Festuca idahoensis* union described for the *Artemisia tridentata vaseyana/Festuca idahoensis* habitat type. Some of the most common species include *Symphoricarpos oreophilus*, *Lupinus* spp., *Galium boreale*, and *Chrysothamnus viscidiflorus* (table 2).

Figure 10.—*Amelanchier alnifolia/Carex* h.t.

Physical Characteristics

This habitat type occurs at elevations ranging from 2,250 m to 2,600 m. Slopes range from 25–70% with north- and east-facing exposures. Nearly all the ground surface is covered with plant growth.

Soils within this type are all dark mollisols. The dominant soil is represented by Clayburn loam, a member of the fine-loamy, mixed family of Argic Pacic Cryoborolls. A few areas have much more gravel in the soil profile than Clayburn loam. The parent material is colluvium and local windblown fine soil material. Geologic formations include Pierre Shale, terrace deposits, Boulder Creek Granodiorite, and biotite gneiss.

Relation to Other Habitat Types

The *Amelanchier alnifolia/Agropyron spicatum* habitat type occurs on rocky soils, has more bare ground, and does not occur in snow drift positions as this *Amelanchier alnifolia/Carex* habitat type. Species that occur in this habitat type, but not in the *Amelanchier alnifolia/ Agropyron spicatum* habitat type, include *Carex* spp., *Festuca idahoensis, Galium boreale, Lupinus* spp., and *Heuchera parvifolia*. This habitat type is slightly dryer and warmer than aspen forest habitat types.

Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule h.t. (Parry rabbitbrush/ Indian ricegrass-short stem wild buckwheat)

This habitat type is characterized by severely eroded slopes, usually with more than 70% of the soil surface devoid of vegetation (badlands) (fig. 11). Because of its eroded appearance, this type is often referred to as unstable. It is a topo-edaphic climax dependent upon steep slopes and erosive soil. Annual overland flow and soil movement maintain the shared dominance of *Chrysothamnus parryi* and *Oryzopsis hymenoides* rather than *Oryzopsis hymenoides* alone as in the less erosive *Oryzopsis hymenoides/Eriogonum brevicaule* habitat type. Other important species include *Eriogonum brevicaule, Chaenactis douglasii, Oenothera caespitosa, Artemisia tridentata, Berberis repens*, and *Amelanchier alnifolia*.

Figure 11.—*Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule* h.t.

Because this habitat type is not very extensive in Middle Park, it was not sampled for species frequency and cover as were other habitat types of the critical mule deer winter range. The modified layer and dominance ratings, as used in the reconnaissance study, were used to characterize this habitat type.

Physical Characteristics

Elevations range from 2,200 m to 2,650 m. Slopes usually range from 30–70% for most aspects, with south- and west-facing slopes more common. Geologic material is primarily of Pierre Shale. The most common soils include Binco, Roxal, Harsha, and Waybe series. The Waybe series is most representative of this habitat type. Waybe is a member of the clayey, mixed (calcareous), shallow family of Typic Cryorthents.

Oryzopsis hymenoides-Eriogonum brevicaule h.t. (Indian ricegrass-short stem wild buckwheat)

This habitat type is characterized by a sparse vegetative cover on light colored, clayey soil with a dominance of *Oryzopsis hymenoides* and associated species including *Eriogonum brevicaule, Haplopappus armeroides, Eurotia lanata*, and *Agropyron* species (fig. 12).

Because this habitat type is not very extensive in Middle Park, it was not sampled for species frequency and cover as were other habitat types of the critical mule deer winter range. The modified layer and dominance ratings, as used in the reconnaissance study, were used to characterize this habitat type.

The *Oryzopsis hymenoides-Eriogonum brevicaule* habitat type is a topo-edaphic climax. The soil surface, occasionally capped with a thin gravel layer, usually has a powdery grayish white appearance. Soils are very erosive; bare ground occupies more than 75% of the area. This habitat type is commonly referred to as stabilized

Figure 12.—*Oryzopsis hymenoides-Eriogonum brevicaule* h.t.

Figure 13.—*Artemisia longiloba/Poa secunda* h.t.

badlands. The *Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule* habitat type is a similar topo-edaphic climax type, but considered as unstable badlands naturally subject to severe gully erosion.

Physical Characteristics

Elevations range from 2,200 m to 2,300 m. This habitat type occupies rolling terrain commonly on ridgetop positions exposed to wind, desiccation, and erosion, but not exposed to the excessive runoff that causes the sharply incised gullies and barren areas characteristic of the *Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule* habitat type.

Soils are developed from Pierre Shale or Troublesome Mudstone. Binco, Roxal, Harsha, and Waybe soil series support this habitat type, but Roxal is most representative. Roxal is a member of the loamy, mixed (calcareous), shallow family of Typic Cryorthents.

HABITAT TYPES OUTSIDE THE CRITICAL WINTER RANGE

Artemisia longiloba/Poa secunda h.t. (alkali sagebrush/Sandberg bluegrass)

This habitat type is characterized by the overstory dominance of the low growing *Artemisia longiloba*, which averages 15 cm in height (fig. 13). This is an edaphic climax specific to heavy clay soils that have a restrictive clay layer at about 25 cm depth. *Sitanion hystrix* and *Poa fendleriana*, both members of the climax association, share dominance in the understory with *Poa secunda*. *Agropyron spicatum* was present in two stands. This is the same habitat type described in North Park by Robertson, Nielsen, and Bare (1966).

Physical Characteristics

Elevations range from 2,350 m to 2,600 m. Slopes range from 0% to more than 35% at most aspects. This habitat type occupies rolling uplands and alluvial fans of the Troublesome Formation and local clayey alluvium. Soils are classified as Argic Cryoborolls.

Artemisia tridentata wyomingensis/ Stipa columbiana h.t. (Wyoming big sagebrush/Columbia needlegrass)

This habitat type is a climatic climax characterized by an overstory of *Artemisia tridentata wyomingensis* with an average height of 33 cm (fig. 14). Associated understory includes *Stipa columbiana*, *Koeleria cristata*, *Sitanion*

Figure 14.—*Artemisia tridentata wyomingensis/Stipa columbiana* h.t.

hystrix, *Agropyron smithii*, and *Poa fendleriana*. As much as 30% of the soil surface is bare, with the cracked surface characteristically forming small polygons. The few forbs present consist mostly of the low-growing *Phlox bryoides*, *Penstemon caespitosus*, and *Eriogonum umbellatum*.

The *Artemisia tridentata wyomingensis/Agropyron smithii* habitat is very similar to this habitat type, but generally occurs at lower elevations on plateaus of the Troublesome Formation or terrace deposits rather than Pierre Shale. Soils are very similar but slightly lighter in color.

The *Artemisia tridentata vaseyana/Festuca idahoensis* habitat type also contains *Stipa columbiana* as a conspicuous understory species.

Physical Characteristics

Elevations range from 2,300 m to 2,450 m. Slopes range from 0–20% at all aspects. This habitat type occupies plateaus usually of Pierre Shale geological material of the Cretaceous Period.

Soils usually are loamy on the surface with an argillic layer of clay accumulation at about 38 cm. The Harsha series, a member of the fine-loamy, mixed family of Borollic Haplargids, is most representative of the habitat type.

Purshia tridentata-Artemisia tridentata vaseyana/ Festuca idahoensis h.t (antelope bitterbrush-mountain big sagebrush/Idaho fescue)

This habitat type is characterized by the shared dominance of *Purshia tridentata* and *Artemisia tridentata vaseyana* shrubs averaging 46 cm in height. This is an edaphic climax specific to sandy soil developed from decomposing basalt, sandstone, or granite. Very little bare ground is exposed except for occasional cobbles or stones that may occupy up to 15% of the area (fig. 15).

Carex species are usually conspicuously present, but the stands studied were usually dominated by *Poa fendleriana* or *Agropyron spicatum*. *Festuca idahoensis* is considered an important climax understory species although it was not represented in all stands studied. *Carex* species and *Balsamorhiza sagittata* are understory indicator species for this habitat type. Other important, but not dominant, species include *Symphoricarpos oreophilus* and *Amelanchier alnifolia*.

Physical Characteristics

Elevations range from 2,400 m to 2,750 m. This habitat type occupies rolling uplands and mountain slopes, especially the Rabbit Ears Volcanics of the Miocene and Oligocene Period.

Figure 15.—*Purshia tridentata-Artemisia tridentata vaseyana/ Festuca idahoensis* h.t.

Agropyron spicatum/Poa fendleriana h.t. (bluebunch wheatgrass/mutton bluegrass)

This habitat type is characterized by its high-elevation position on bald, wind-swept ridgetops. Most shrubs are absent or very short. *Agropyron spicatum* and *Poa fendleriana* are dominants. Forbs such as *Castilleja flava* and *Potentilla concinna* indicate a more mesic environment than the lower-elevation *Agropyron spicatum/Artemisia frigida* habitat type. *Koeleria cristata* is usually present. The absence of *Oryzopsis hymenoides*, *Eriogonum brevicaule*, and *Bouteloua gracilis* differentiates this habitat type from the *Agropyron spicatum/Artemisia frigida* ridgetop habitat type.

Physical Characteristics

Elevations range from 2,400 m to 3,050 m. This habitat type occupies ridgetops of shallow, gravelly, dark-brown soils. Soils are usually of the loamy-skeletal, mixed family of Lithic Cryoborolls represented by the Quander soil series (fig. 16).

Artemisia tridentata vaseyana/Festuca thurberi h.t. (mountain big sagebrush/Thurber fescue)

This is a climatic climax characterized by the distinct dominance of tall *Artemisia tridentata* subsp. *vaseyana*

Figure 16.—*Agropyron spicatum/Poa fendleriana* h.t.

averaging 67 cm (fig. 17). The understory is dominated by large tufts of *Festuca thurberi* and such other mesic grasses as *Poa nevadensis*, *Stipa columbiana*, and *Carex* species. Other important species include *Lathyrus leucanthus*, *Lupinus* species, *Castilleja flava*, and *Delphinium occidentale*. Disturbed sites may be dominated by *Chrysothamnus nauseosus*.

Physical Characteristics

Deep, dark, Mollic upland soils (classified as Cryoborolls) and located adjacent to forest habitat types provide good evidence of this habitat type, even when the vegetation is disturbed.

Figure 17.—*Artemisia tridentata vaseyana/Festuca thurberi* h.t.

Elevations range from 2,550 m to 2,900 m. It occurs at most aspects at high elevations, but usually north and east aspects at lower elevations. Deep snow accumulates in winter.

Artemisia cana/Festuca thurberi h.t. (silver sagebrush/Thurber fescue)

This habitat type is characterized by the overstory dominance of *Artemisia cana*, averaging 71 cm tall, and an understory dominance of *Festuca thurberi* (fig. 18). Other commonly associated shrubs include *Potentilla fruticosa*, which increases in abundance with disturbance and becomes dominant in early seral stages of succession. Other important species include *Bromus anomalus*, *Poa nevadensis*, and *Delphinium occidentale*.

This habitat type is colder and more mesic than the *Artemisia tridentata* habitat types. It has an environment similar to the *Amelanchier alnifolia/Carex* habitat type, but is not restricted to snowdrift microsites, although snow is usually deep in winter. Aspen (*Populus tremuloides*) dominates at slightly warmer and moister environments. Colder and moister environments support spruce (*Picea* spp.) forest communities.

Figure 18.—*Artemisia cana/Festuca thurberi* h.t.

Physical Characteristics

Elevations range from 2,400 m to 3,000 m. Slopes are usually less than 10%. This habitat type is a topographic climax that occupies alluvial flood plains near willow (*Salix* spp.) stream bottoms and adjacent to aspen (*Populus tremuloides*) and Douglas-fir (*Pseudotsuga menziesii*) forest communities. Soils are usually cold, deep Mollisols (cumulic or pachic) such as the Mord series classified as a member of the fine, montmorillonitic family of Boralfic Cryoborolls. The Cimarron soil series is also characteristic of this habitat type.

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APPENDIX

Dichotomous Key to the Shrub-Steppe Habitat Types (h.t.) of Middle Park, Colorado

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1a. *Amelanchier alnifolia* the dominant overstory species (2a).

2a. *Agropyron spicatum* the dominant understory species, soils are stony and cobbly, more than 30% of the soil surface is bare of vegetative cover.

Amelanchier alnifolia/Agropyron spicatum h.t.

2b. *Agropyron spicatum* not the dominant understory species, soils are deep dark brown Mollisols, less than 10% of the soil surface is bare of vegetative cover.

Amelanchier alnifolia/Carex h.t.

1b. *Amelanchier alnifolia* not the dominant overstory species (3a).

3a. *Artemisia longiloba* the dominant overstory species, a dense clay pan of shrink-swell clay occurs at less than 38 cm depth.

Artemisia longiloba/Poa secunda h.t.

3b. *Artemisia longiloba* not the dominant overstory species, soils do not necessarily have a dense clay pan at less than 38 cm depth (4a).

4a. *Juniperus scopulorum* the dominant overstory species.

Juniperus scopulorum/Agropyron spicatum h.t.

4b. *Juniperus scopulorum* not the dominant overstory species (5a).

5a. *Festuca thurberi* the dominant understory species, soils deep dark Mollisols at elevations usually over 2530 m (6a).

6a. *Artemisia cana* the dominant overstory species, high elevation valley bottomlands.

Artemisia cana/Festuca thurberi h.t.

6b. *Artemisia tridentata vaseyana* the dominant overstory species, sloping uplands.

Artemisia tridentata vaseyana/Festuca thurberi h.t.

5b. *Festuca thurberi* not the dominant understory species, soils not necessarily deep dark Mollisols, elevations not necessarily over 2530 m (7a).

7a. *Artemisia tridentata* the obvious dominant, *Sarcobatus vermiculatus* and *Purshia* tridentata absent or inconspicuous, usually not on windswept ridgetop positions (8a).

8a. *Artemisia tridentata vaseyana* the dominant overstory species, at least 5 members of the *Festuca idahoensis* union present, soils usually dark Mollisols.

(The *Festuca idahoensis* union is described in the *Artemisia tridentata vaseyana/Festuca idahoensis* h.t.)

Artemisia tridentata vaseyana/Festuca idahoensis h.t.

8b. *Artemisia tridentata vaseyana* absent or rare (less than 10% of the *Artemisia* individuals fluoresce when water extract from their leaves is placed under ultraviolet light), less than 5 members of the *Festuca idahoensis* union present, soils not usually dark Mollisols (9a).

9a. *Artemisia tridentata tridentata* dominant averaging more than 63 cm in height, stream terraces or concave depressions, elevations less than 2440 m.

Artemisia tridentata tridentata/Agropyron smithii h.t.

9b. *Artemisia tridentata tridentata* inconspicuous, *Artemisia tridentata wyomingensis* present averaging less than 63 cm in height (10a).

10a. *Agropyron spicatum* the dominant understory species; soils usually less than 50 cm to bedrock, gravelly and cobbly at the surface.

Artemisia tridentata wyomingensis/Agropyron spicatum h.t.

10b. *Agropyron spicatum* not the dominant understory species; soils not gravelly to the surface but often crusted and cracked, deeper than 50 cm to bedrock (11a).

11a. *Agropyron smithii* the dominant understory species; *Stipa columbiana* absent, elevations less than 2320 m.

Artemisia tridentata wyomingensis/Agropyron smithii h.t.

11b. *Agropyron smithii* not the dominant understory species, *Stipa columbiana* present, elevations greater than 2320 m.

Artemisia tridentata wyomingensis/Stipa columbiana h.t.

7b. *Artemisia tridentata* not usually dominant but may share dominance with other shrubs (12a).

12a. *Purshia tridentata* dominant or sharing dominance with *Artemisia tridentata*, soils usually developed from basalt parent material.

Purshia tridentata-Artemisia tridentata vaseyana/Festuca idahoensis h.t.

12b. Not as in 12a (13a)

13a. *Sarcobatus vermiculatus* the overstory dominant or sharing dominance with *Artemisia tridentata tridentata*, soils usually clayey occupying saline alluvial fans.

Sarcobatus vermiculatus-Artemisia tridentata tridentata/Agropyron smithii h.t.

13b. Not as in 13a (14a)

14a. Ridge top positions, most shrubs absent, slopes not severely eroded or gullied (15a).

15a. Elevations greater than 2440 m, many members of the *Festuca idahoensis* union present.

Agropyron spicatum/Poa fendleriana h.t.

15b. Not as in 15a (16a)

16a. Soils usually cobbly and gravelly to the surface, *Agropyron spicatum* and *Artemisia frigida* dominant.

Agropyron spicatum/Artemisia frigida h.t.

16b. Soils usually not cobbly or gravelly to the surface, but white to gray colored clay, soil is powdery when dry; *Oryzopsis hymenoides* is dominant. *Eriogonum brevicaule* and *Haploppus armeroides* are usually present.

Oryzopsis hymenoides-Eriogonum brevicaule h.t.

14b. *Chrysothamnus parryi* present, slopes severely eroded (badlands).

Chrysothamnus parryi/Oryzopsis hymenoides-Eriogonum brevicaule h.t.

Tiedeman, James A., Richard E. Francis, Charles Terwilliger, Jr., and Len H. Carpenter. 1987. Shrub-steppe habitat types of Middle Park, Colorado. USDA Forest Service Research Paper RM–273, 20 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

The shrub-steppe vegetation was classified into 17 habitat types in relation to plant species canopy cover, and physical characteristics. Grazing and browsing by wildlife and livestock have been, and are expected to continue to influence the development and maintenance of stable plant communities in Middle Park. The habitat types emphasize critical mule deer winter range and are considered climax, each modified by zootic, edaphic, climatic, and/or land form factors. Phytoedaphic characteristics, ground photos, and a habitat type key are presented and discussed.

Keywords: Shrub-steppe habitat types, vegetation classification, sagebrush (*Artemisia tridentata*), mule deer winter range, Middle Park, Colorado

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U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

Rocky Mountains

Southwest

Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

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Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

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Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526